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ABSTRACT

This booklet is the sixth of a series of 16 booklets that together describe and present findings for a study which involved field observations and a survey of science teaching and learning in American pulic schools during the school year 1976-77. The study was undertaken to provide the National Science Foundation with a portrayal of current conditions in K-12 science classrooms to help make the Foundation's programs of support for science education consistent with national needs. Eleven high schools and their feeder schools were selected to provide a diverse and balanced group of case study sites. One field researcher was assigned to each site and instructed to find out what was happening and what was felt important in science (including mathematics and social science) programs. The case study report from the "Urbanville" site - a metropolitan community of the Pacific Northwest - is contained in this booklet. (MN)

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Case Studies in Science Education
A project for the National Science Foundation
conducted by CIRCE and CCC
270 Education Building
University of Illinois at Urbana-Champaign

BOOKLET V

SCIENCE EDUCATION IN URBANVILLE: A CASE STUDY

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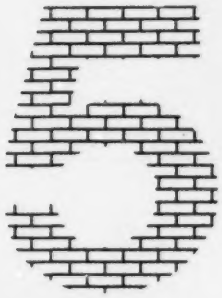
University of Minnesota

April, 1977



Even in a day of television and air travel, the northwest--northern California, Idaho, Oregon, Washington, even if Alaska were not to be included--is one of the most remote parts of the country. The mountains, the ocean, the distances, the time zones, and a resentment against further in-migration place it beyond the touch and ken of most Americans.

But it is not beyond the touch of the economic, social, and political problems of the rest of the states. And the schools are not greatly different from many we found in Texas and Ohio.

Our observer, Wayne Welch, spent most of the fall term of 1976 in a high school he called Hardy High. He reported that the major forces pressing for change at Hardy were: (1) declining enrollments; (2) rising costs but failures at the polls of special levies; (3) desegregation legislation; (4) accountability pressures; (5) concern about children learning the basic skills; and (6) changing student attitudes. We were intrigued by his development of these forces against a background of subsystem enclaves. He found highly bounded administrative and teaching subsystems, both characterized by geniality and respect for the other--but both appearing to strive for minimum interconnection.

Some of the details of these things are not common to what we found across the country--for example, the absence of local funding for the schools unless the levies passed. But the general circumstances will be recognizable to Piedmont and Prairie readers. The constraints of teacher-strikes and bus-schedules, the football hyperbole, and the social etiquette of the lunchroom are almost universals--played out again

in this far corner to frame the science teaching and learning in Hardy High and its configuration of feeder schools.

Wayne Welch is an expert in those forms of student testing and attitude measurement that relate to the science curriculum. On numerous occasions he has been an adviser to and a researcher for the National Science Foundation. We were pleased to find an observer to bring that special perspective to the scene. Perhaps more than any other of our observers, he has watched the success of efforts to reform the precollege science curriculum, and their lack of success. He knows the array of alternatives--pedagogical and substantive--that are potentially available to the American science teacher. His report should be read with a sensitivity to these opportunities--and the obstacles and costs.

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SCIENCE EDUCATION IN URBANVILLE: A CASE STUDY

Wayne W. Welch

BACKGROUND

To many, the image of a large city high school is a three-story, dirty brick building erected about the turn of the century. The playgrounds are paved with asphalt, and guarded by six feet of chain link fence. Occasionally, classroom bulletin boards display a splash of color, but for most the dreary picture of schools painted by The Blackboard Jungle and Up the Down Staircase covers the canvas of our minds.

Such an image was in my mind prior to a recent study of science[1] education conducted in a school located in a large metropolitan area. But was this an accurate image? What does an American school in 1976 look like to an outside observer? What issues and problems occupy the minds and hearts of students, teachers, and parents? And can these concerns be recognized in an eight-week study? These, and other questions, are the focus of this report.

The specific purpose of the study was to portray as clearly as possible what is currently happening in science in a typical secondary school cluster. (A cluster is a senior high school together with its junior high school, and feeder elementary schools.) The methodology used is called case or field study research. This type of research is an intensive study of the background, current status, and environmental interactions of a given social unit: an individual, group, institution, or community (Issac 1971). Case studies are in-depth investigations designed to yield a complete and organized picture of the unit under study. Understanding is sought through observations, interviews, archival searches, and discussions. The observer becomes the chief research instrument for gathering information.

The target unit of the present study is the science education program of a school in a large (greater than 250,000 population) U.S. city. We will call the city Urbanville and use fictitious names for schools and faculty. The school was thought to be somewhat innovative, but with no special national reputation. The socio-economic status of the community was judged high prior to the start of the study.

The initial contact with the Urbanville Public Schools was made by the project headquarters at the University of Illinois. They outlined the purposes of the study and explained that an observer wanted to spend several weeks in one of their schools observing the science, mathematics, and social science programs.

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[1] In this paper, science is meant to include mathematics, natural science and social science.

Approval for such an undertaking was obtained at the district level following the submission of "three typed copies of the following: a) request to conduct research form, b) all questionnaires, tests, forms and communications that will be given to participants, and c) synopsis of the proposed study (if appropriate)." The Research Office responsible for processing the application was most cooperative and approval was obtained on September 15, 1976. However, the approval by the district did not insure cooperation of the target school, as each principal is free to decide whether or not to participate in studies of this kind. While permission for the study was being sought, Urbanville teachers voted to go on strike two days prior to the opening of school, the first teachers' strike in the school's history. The main issues centered on a fair layoff and recall policy, an end to mass RIFing (reduction in force), some program restorations, fair transfer procedures, an acceptable staff evaluation process and a union demand for an agency shop. Two years of severe budget cuts and declining school enrollment had created a situation where all teachers with less than eight years seniority had been fired on April 15. Although some were eventually hired back on one-year contracts by late summer, the uncertainty of the job situation created grave concern among the teachers.

On September 13, four days after the strike began, the schools were closed due to low attendance and the potential loss of several million dollars in state aid, while negotiations stalled. Eventually, compromise and the intervention of high state officials ended the ten-day strike. The teachers generally achieved their demands and school started again on September 22, approximately two weeks late. The teachers achieved a consistent lay-off and hire policy, and a closed agency shop for the teachers' association was approved.

While the strike was in progress, some background information on the district was obtained in the Research Office and from the science supervisor in the city. Finally, early in October, the first contact with the target school was made. (In this report, the school is called Thomas Hardy Senior High School.)

On October 4, I made my first contact with Mr. Don McKay, the principal of Hardy High School. A brief conversation on the telephone led to a 10:30 a.m. appointment on the following day. As I drove to the northern part of Urbanville on Tuesday morning, I felt some concern about my reception. Suppose he refused to participate? What effect had the strike had on the atmosphere of the school? It had been thirteen years since I last taught high school and I wondered how things had changed.

As I turned right on Evergreen Street and started down the hill, I noticed a sprawling yellow brick building outlined with white trim. A red, white, and blue Patriot (the school mascot?) painted on a single chimney stood guard over the school. A modern two-story building, about a dozen years old, was nestled in a large grass-covered valley. A raft of tennis courts was flanked by football and baseball fields, and several adults were jogging on a path that circled the gridiron. Several temporary buildings, painted a dull orange, were behind the school, and a large parking lot was filled with brightly colored cars. The whole setting was surrounded by an amphitheatre of green pine trees, yellow maple leafs, and manicured lawns leading from the street to single-dwelling homes. For a moment, I thought I had escaped the city boundary and had mistakenly arrived at one of the surrounding suburbs. But no, the silver block letters to the right of the white-pillared entrance clearly spelled out: HARDY HIGH SCHOOL, 1963.

As I pulled into one of four parking spaces marked VISITOR, I thought how far wrong my expectations for the appearance of the school had been. I locked my car doors and went through the main entrance. The halls were filled with students, talking and walking, and I was struck by how similar the picture was to the Milwaukee suburban school I left in 1963. I entered a door marked OFFICE and introduced myself. They were expecting me.

Mrs. Steel, the principal's secretary, ushered me into a large, neat office. Mr. McKay, the principal, rose to shake hands and motioned me to sit at a table surrounded by four pink

molded chairs. We exchanged pleasantries about the weather and my newness to the area, and I proceeded to tell him about my mission. For the first thirty minutes he listened carefully, occasionally interrupting with a question. I was somewhat uneasy because I sensed he was skeptical of the idea. However, the uniqueness of the study, the opportunity to provide information to federal decision makers and the fact that his school was one of only ten in the country selected for this study seemed to capture his enthusiasm. By the end of the next hour he had told me all about his school, showed me about the building, and arranged for me to meet with the department chairmen in math, science and social studies. Furthermore, he had given me a room for an office, assigned a mailbox and provided unlimited access to the coffee machine. I had crossed that initial barrier and seemed welcome in the school.

Once the support of Mr. McKay was obtained, the other pieces seemed to fall in place quite easily. The department chairmen made it possible to meet the department faculties. The junior high principal, Mr. Arkin, learned of my presence at Hardy, and was very receptive when I finally contacted him. And all four of the elementary principals I visited were very helpful in making arrangements for my visits to their buildings. The cooperation and assistance of a key person, in this case Mr. McKay, the principal, seems a critical factor in studies of this sort.

Because qualitative research, in general, and case studies, in particular, have not been used a great deal in science education research and evaluation, some attention is directed toward the process in this report. It may be that the hindsight of experience will provide some guidance for future studies of this type and help the reader to better judge the validity of the conclusions. A summary of the methodology as it was carried out is found in the appendix.

THE CURRENT PICTURE

Hardy Senior High

Situated in a city with a dozen high schools, eighteen junior high schools, and nearly a hundred elementary schools, Hardy has a number of educational strengths. Its building is one of the newest in the city, and the area it serves contains many of the ingredients which are supportive of education. It ranks first in the city in percentage of homeowners (74%) and young adults (ages 25-44), and ranks second in the percent of parents who are high school (75%) or college (20%) graduates. An indication of interest in education is found in the fact that approximately 55% of the graduates eventually go on to college and eight or ten national merit finalists are common among the senior class.

Nearly 1600 students and fifty-seven teachers seem to live day by day in relative harmony and one gets the immediate impression of an active and friendly environment. Amid the poster-covered walls urging students to vote for this class president or to join that society are found mementos of successes in arenas outside the classroom. The girls' softball team (coached by the psychology teacher) is undefeated, the cross country teams (boys and girls) were first and second in the state meet, and the football team boasts a 7-1 record and includes a high school All American player. One senses a feeling of pride and accomplishment among the students.

The teachers are generally very experienced (most are over thirty-five) and seem competent in their respective subject areas. They are casual in dress and, with few exceptions,

friendly and warm people. The reprimands heard through the open door of the vice principal's office, the frown on the face of the dean of students, and conversation in the smoky faculty lounge hint at an occasional problem not witnessed by the casual observer.

Science

The natural science program at Hardy is strong. It is paced by an active biology program team-taught by three full-time and one part-time teacher. Currently 472 students (93% of sophomore enrollment)[2] are enrolled in a laboratory course led by the department chairman. The classrooms are filled with science artifacts (birds, weather maps, rocks, specimens, snakes, etc.) and the spirit of the group can be portrayed by two episodes: an open session with students one day after school to discuss the implication on science of the presidential election, and a week-end assault on the walls separating the three biology rooms resulting in open portals that central administration had stalled on for nearly two years.

Probably 80% of the class time is spent by students working on experiments; and three different tracks (developed locally) are provided, depending on student ability. The course is patterned after college science courses and seems difficult for many of the students. However, teacher enthusiasm and interest seem to rub off on students and they rate the course very good. Marine biology, human physiology, mushrooms, and wildflowers are other courses offered as part of this strong program. Exactly which courses will be offered a given semester depends a great deal upon student interest. A college style registration procedure is used and if a given course doesn't "fill" (i.e., be selected by more than twenty-five students), then it may not be offered. Conversely, sections are added if student interest is high.

During the semester following the site visit, the life science enrollment was as follows:

Biology II	250
Molecular Biology	29
Marine Biology	53
Wild Flowers/Edibles	34
Human Physiology	53

Apparently some of those students in the first semester of biology opt for more specialized courses the second semester.

The first year of chemistry is currently taken by 146 students (27% of junior enrollment) and is taught as a laboratory science. The five sections of chemistry are handled by the physics teacher and a chemistry teacher who also teaches biology. The CHEM study texts are used and the course is viewed by students and teachers as primarily a college-prep course. A third semester of general chemistry and a semester of organic chemistry are offered if enough students register for these courses.

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[2]This figure is obtained by dividing the total biology enrollment by the number of sophomores. However, some juniors and seniors take biology and some sophomores take other sciences.

Physics may be taken in either the junior or senior year and currently sixty-eight students (13% of senior enrollment) are enrolled. About half the group are girls, which is perceived by students and teachers to be the result of changing female roles. Counselors, parents, and friends are relaxing their attitude that advanced science is only for males. The course has some laboratory components, but in general is taught more like a math class; that is, explain concepts, assign problems, correct problems, discuss difficulties. This routine is interrupted occasionally by exams or experiments, but the "doing of problems" dominates over the "doing of science" found in the other classes. The class is clearly for the academically elite and the teacher sees no need to try to increase enrollments. At one time the PSSC and the ECCP courses were used, but this year the Holt-Rinehart-Winston book, Modern Physics, is being tried and will probably become the district-wide text for next year.

The rest of the science program includes a semester of geology and a science seminar. The geology situation portrays quite well some of the current problems in the school. Because of staff cutbacks, the assistant principal was teaching one section of geology this fall. After two weeks of school, a displaced junior high teacher was assigned by the district office to teach math and science. He took over the geology class along with several math classes and the assistant returned to full-time administration. The new teacher was encountering some difficulties in the class because students were irritated by the changes. In fact, in one class, there were four different teachers during the first month of school.

An adjunct to the science program is a popular horticulture program offered in the industrial arts department. In a temporary building and greenhouse located about two blocks from the main building, 113 students were enrolled in environmental horticulture. The course meets the state requirements for a laboratory science and while it is considered a strong program by the science teachers, there seems to be very little interaction between it and the rest of the science program. It has grown through the efforts of an active teacher whose academic home is industrial arts.

The science program is strong and surviving, but it is being subjected to many challenges: transfer teachers, declining budgets for texts and equipment, and competition from the "basics." It may be seriously affected if subjected to many more problems.

Mathematics

Mathematics at Hardy High School is traditional in its components, sequence, and text books. Its five full-time teachers are experienced (average age is over forty) and appear to be competent in their mathematics training. The staff also includes four part-time teachers who are shared with other departments: science, physical education and language arts. These teachers are younger, yet with one exception were thought to be qualified in the subject.

One year of math in grades nine--twelve is required for graduation. A three-year college-prep sequence that follows ninth-grade algebra is offered. In addition, there is an accelerated or honors track, and two options for non-college bound students: basic math, and a two-year algebra sequence. Current sequences and enrollments are shown in Table I.

TABLE I
HARDY H.S. MATH PROGRAM
(Fall 1976)

Grade	College Prep	Advanced	Other	
10(522)	Geom(245)	Geom (Honors) (29)	Algebra I (99)	Basic Math (44)
11(542)	Alg-Trig(121)	Adv Math(32)	Algebra IIA(50)	Basic Math (39)
12(506)	Math Anal(29)	Calculus(28)	-	Basic Math (66)

( ) Enrollments are shown in parentheses

There are thirteen classes with 395 students in the regular college sequence. One class at each grade level is in an honors sequence. The eight classes of basic math are part of a "minimum competency" program recently inaugurated at Hardy. All students must pass (get 70%) a basic skills exam prior to graduation (although the rule has yet to be enforced). In addition, this Minimum Competency Test is a prerequisite for the two-year introductory algebra sequence.

Conventional textbooks with 1960s copyrights are used in most classes. Textbooks by Dolciani had been most often selected. In all math classes I visited, the sequence of activities was the same. First, answers were given for the previous day's assignment. The more difficult problems were worked by the teacher or a student at the chalkboard. A brief explanation, sometimes none at all, was given of the new material, and problems were assigned for the next day. The remainder of the class was devoted to working on the homework while the teacher moved about the room answering questions. The most noticeable thing about math classes was the repetition of this routine. Although it seemed boring to me, students and teachers seemed comfortable with it. Apparently it fulfills student expectations and provides the students opportunity for closure.

Social Studies

Although NSF and university professors may think in terms of social science, the program at Hardy is better described as social studies. It enrolls nearly 1100 students handled by a faculty of nine teachers (teaching load is five periods during a six-period day). Five are full-time in the department while the other four are shared with music or foreign language.

The variability in experience, style, and quality seems greater among these teachers than in science and math. The department contains two teachers considered the best in the school by many students, and also two of the poorest. Classes I observed varied considerably as well; in one instance, I witnessed an exciting small group discussion in the learning center on conflict resolution, while in a U.S. History Class I saw an Encyclopedia Britannica film on the Virginia Constitution which was deemed so important that no mention was made at all of the previous day's presidential election. The teacher's rigid lesson plan and his failure to relate to students resulted in a missed opportunity to make history "come alive."

The graduation requirements in social studies are greater than the one year required in science and math. Sophomores must take a semester of world history and juniors need a year

of U.S. history. A semester of the state history is required, but it may be taken in junior high school. Until this year, a course in "Problems of Society" was required at the twelfth grade. This requirement was dropped by the state but is still offered as an elective. Offerings and enrollments are shown in Table II.

TABLE II
HARDY H.S. SOCIAL STUDIES PROGRAM
(Fall 1976)

	Grade		
	10	11	12
COURSES OFFERED	World Hist(9)* State Hist(1)	U.S.Hist(18)	Contemporary Society(2) Psychology(3) Anthropology(2) Economics(1)

*Numbers in ( ) are the number of sections. Each section is about 30 students.

Electives in the Far East, the Soviet Union, and one called "War and Peace" are available during the spring semester. The number of sections offered, if any, depends upon student requests. And student requests seem to depend a great deal on peer and sibling advice.

Jefferson Junior High School

Located across the street from the high school in a two-story brick building erected about 1953 is the week-day home of 1360 seventh-, eighth-, and ninth-grade students. Fifty-four teachers, three administrators, three counselors, a nurse, five secretaries, seven custodians, nine lunchroom staff, and a human relations associate are charged with preparing students to make the move across Evergreen Street to Hardy a relatively easy journey.

The building is older, seems more dreary than the high school, and the pushing and shouting in the halls creates a much different atmosphere. Classroom behavior is good, however, and the staff generally appear capable, although more uncertain of their ability than Hale teachers. (Perhaps this mirrors the anxiety of their twelve- through fourteen-year old students.) Like their Hardy counterparts, they are experienced teachers (most in their thirties and forties) and seem competent in their subject. Nearly all are teaching in subjects in which they have majored. The school is very similar to the high school. The philosophy, curriculum, daily schedule, organization, even the lunch room program are patterned after the big brother across the street.

Science

The science program at Jefferson has several strong teachers, but has been cut back in recent years as more and more electives are sacrificed for required courses. An active faculty of four provides the required semester of biological science in seventh grade and

physical science in eighth. An elective class of oceanography and one of earth science are all that are taken in the ninth grade. The science is strongly lab oriented (although less so in eighth grade), and two of the teachers run several science field trips a year--some of two weeks duration. The textbooks are conventional, but the courses contain many teacher-developed diversions from the printed pages.

Mathematics

A full year of mathematics is required for seventh and eighth graders, and nearly all ninth graders (98%) elect a full year of math. The ninth-grade class for the average or above average student is algebra. Those students in the accelerated program of seventh and eighth grades take an accelerated algebra course. (Approximately half of these opt for the honors geometry course in tenth grade.) A general math course is available to ninth graders, apparently for the below-average student, which satisfies the ninth-through-twelfth-grade math requirement or is preparation for the two-year algebra sequence.

Again, as in the high school, the math program is characterized by its conventional textbooks and its routine of correcting papers, explaining difficulties, and assigning more problems. Enrollment in mathematics is high, and the district priority on mimimum competency in reading, language arts, and math should keep it that way.

Social Studies

More social studies courses are required at Jefferson than science courses (five semesters compared to two in science). State history and U.S. history are required in the seventh grade. A semester of world geography is mandated for eighth-grade and students choose an elective for the other half year. About fifty eighth-graders choose civics and urban studies; but typing, piano and health education are strong competition for a second semester of social studies. In the ninth grade, a year of world history is required of all students.

Eight full-time teachers comprise the social studies department. They have an average of nine years experience. Here, as at Hardy, considerable variation was noted among the classes in content, style, and interest. However, description and recall are far more prevalent in class discussions than inquiry or analysis.

Elementary Schools

A typical elementary school in the Hardy cluster of the city of Urbanville contains about 300 students (K-6) and fourteen teachers, including a librarian. Those schools enrolling fewer than 300 pupils are assigned a half-time librarian. The principal serves a unique role of boss, shepherd, counselor, and manager all rolled into one. He/she is usually the major factor in the school's operation, as teachers seem more deferent to the principal than in the junior or senior schools.

The physical appearance and the emotional climate vary from school to school, with some being open, bright, and cheery, and others being closed, guarded and dreary. To some extent this mirrors the personality of the principal, but it is difficult to assign a cause-and-effect result. Children at this age are delightful and it isn't long before a smile

crosses your face as you watch their unbounded enthusiasm and curiosity. Sometimes this energy competes against the rules and order desired by the teachers.

Elementary teachers seemed happier in their job than did their secondary counterparts. There were more smiles and fewer complaints in the teachers' lounge. The battle lines between students and teachers are not so clearly drawn and learning seems more of a joy than a conflict.

Reading and language arts dominate the curriculum, even at the upper levels. Mathematics is a distant second but it is considerably ahead of anything else. Principals rank the relative emphasis at the elementary level this way:

1. Reading
2. Mathematics
3. Social studies
4. Physical education
5. Health/science
6. Music
7. Art

A reported schedule of a sixth grade teacher also illustrates the situation.

9:00 - 10:00	Language arts
10:00 - 10:10	Recess
10:10 - 11:00	Math
11:00 - 11:40	Social studies
11:40 - 12:30	Lunch-recess
12:30 - 12:45	Spelling
12:45 - 1:20	Language arts or math again, depending on problems
1:20 - 1:30	Recess
1:30 - 2:30	P.E., science, art, music, health

This schedule, or one like it, is typical of all the elementary schools. Science competes with art, music, health (sometimes considered science by teachers), P.E., and whatever else may impinge on the end of a school day, e.g., parent conferences scheduled for two weeks. And science is losing the battle. It receives very little attention.

The curriculum guide for the district, which is seldom used by teachers, recommends about ninety minutes a day for language arts (including reading), about forty minutes per day for math, and thirty each for science and social studies. Other subjects are recommended lesser amounts. Greater influences on teacher decisions are principal pressure, or encouragement, and current district priorities. The latter currently are on such things as minimum competencies in reading and math, desegregation, accountability, and public relations in the community. Science and social studies are being largely ignored.

Probably the most important observation for the purposes of this study at the elementary level is the small amount of science that is being taught. Only an occasional teacher or principal who is interested in the area generates interest that may spread throughout the building. Otherwise, one is most likely not to see any science at the elementary level.

Social studies is given more attention, but even this is diminishing as the move for competency (with its increased time requirements) and other demands grow. Teachers seem to be willing to teach social studies more than science, but less and less time is available.

Mathematics occupies a valued position in our schools these days. This is somewhat surprising, given that most students find it boring. However, parents, boards, and teachers see it as an important skill, and drill on long division appears with greater frequency in the classroom. The "new" math is now old, and -- with cries of "Johnny can't add!" -- is rapidly disappearing from the curriculum.

So too in science one must look hard to find a SCIS lesson or an ESS unit. USMES, Minnemast, and MACOS are foreign words to most teachers. Traditional text series occupy the shelves. Teachers who tried some of the newer curricula have changed back. Except for the impact it produced on the commercial texts, the NSF curriculum development venture in Urbanville is a thing of the past.

SOME LENGTHENING SHADOWS

Although Thomas Hardy High School is making good contributions to the education of the students of north Urbanville, the system has undergone severe pressures the past half dozen years that present a real threat to the school. Major socioeconomic forces have immediate effects. For example, the loss of a special bond issue reduces the number of elective courses. The system can accommodate a number of shocks, but sooner or later it begins to react, sometimes violently, sometimes more subtly. And although the educational institution in this country is extremely resilient, it can be hurt by severe and persistent forces. The major forces, their immediate impact, and some growing reactions as I see them, are outlined in Table III (see page 5-11).

A strong impact on this district has come from the decline in numbers of school age children. From a high of 100,000 pupils in 1970, the enrollment has dropped to 60,000 in 1976. Decreasing birth rates, outward migration of younger families and, to a lesser extent, transfers to private schools have all played a role. Enrollment figures for the past twelve years at Hardy tell the story.

YEAR	PUPILS	TEACHERS
1964	1875	81
1965	2002	83
1966	1984	88
1967	2132	94
1968	2150	95
1969	2221	96
1970	2142	92.5
1971	2112	90.5
1972	2053	83.5
1973	1939	80
1974	1833	71.2
1975	1688	72.2
1976	1576	57

The situation is the same in the feeder schools. From the high water mark of 1969-70, there has been a 30% drop in number of students and a reduction of 43% in the number of teachers.

Coupled with this decline has been the difficulty in passing the yearly bond issue required to raise the per-pupil expenditures above the state-provided minimum of $725. The special levy failed in 1974-75 for the first time, causing much belt tightening; and the budget of the current year is far below what the teachers and administrators believe is needed. But a public offered an opportunity to vote against rising taxes in an inflationary

TABLE III

FACTORS AFFECTING THOMAS HARDY HIGH SCHOOL

MAJOR FORCES	SHORT TERM IMPACT	SOME REACTIONS
1. Declining enrollments	a. Teacher firings	A. Increasing teacher militancy, strike, growth of union
2. Inflation/failure of special levies	b. Reduction of support services	B. Less satisfaction with teaching
3. Desegregation laws	c. Aging texts & teachers	C. Separation of institutional, managerial, and technical systems
4. Accountability movement	d. Less equipment/supplies	
5. Concern about basic skills	e. More classroom space	
6. Changing student attitudes	f. Fewer electives	
	g. Minimum competency programs	
	h. Less flexibility	
	i. Greater demands on teachers/ administrators	
	j. More red tape	
	k. Public relations sensitivity	
	l. Teacher transfers	
	m. Special skill development programs	
	n. Racial problems	
	o. Fewer discipline problems	
	p. Increased student interest in school	

period becomes a force to be reckoned with. More often than not, the final school budget is not determined until late summer. At present, all teachers with less than eight years seniority have been fired and have lost their seniority. Many have been hired back in August for one year, but the fear and uncertainty for the future year are great. One teacher told me she has been fired and re-hired seven years in a row. Because there are few new teachers being hired, the average age of the remaining teachers is increasing.

District budgets for the past three years have been $116 million, $110 million, and $108 million. The drop in purchasing power is even greater, of course. In addition to teacher RIFing, there have been cuts in support services (e.g., curriculum specialists, librarians, demonstration classrooms) and less money for laboratory equipment and supplies (even paper is becoming a commodity). Texts are not being replaced. Most copyright dates I saw were about 1965.

The school day has been shortened from six to five periods with no study halls, and the number of electives has been reduced. Flexibility in scheduling and opportunities for innovations are practically non-existent, except within the classroom. One positive outcome has been the increase in available space, but more often than not this means un-used and empty rooms.

Desegregation and other federal laws have created their share of problems for the day-to-day operation of the schools. Last year, fourteen Hardy teachers were "displaced" to other schools because of reduced enrollment and the need to make places for incoming minority teachers. While the purpose of such a program is admirable, the impact on people's lives is enormous. (For example, after teaching at Hardy High School for eight years, Miss Wainwright found out on September 5 that she will be teaching a new subject at a school fifteen miles from where she has been teaching.) Because of such impact, teachers and administrators try hard to keep these "career reconstructions" at a minimum, regardless of the social causes they might serve.

Although bussing has not been implemented in Urbanville, there is a strong movement for admitting voluntary racial transfers and other forms of desegregation. Four years ago, the mixing of Asian, black, and white students did create some problems leading to a brief student riot. But racial strife is not apparent now. Left over from more troubled times is a security officer who seems to have little to do, two human relations staff, several minority clubs, and a host of problems for administrators, counselors, and teachers. Future integration plans (e.g., magnet schools) are likely to create even greater demands on the system.

Parents of Hardy students have expressed considerable concern for public institutions. The community is demanding that organizations such as the medical profession, bureaucracies, and schools be responsible for providing their promised or expected services. In addition, parents are concerned about declining test scores and the apparent inability of their children to spell, read, write, and compute. These concerns and interests have led to greater demands on teachers and administrators resulting in such things as management by objectives, performance goals, and the publication of test scores by school building. The paper work and red tape have increased exponentially as principals ask teachers for their statement of yearly goals and central administration asks principals for their building goals.

Evaluation of teachers is increasing (with its attendant anxiety); district courses such as "Positive Image Building and the Educator" are available for teachers. The potential value of these teacher evaluations, though, is uncertain. Evaluation creates anxiety and tension, perhaps justified, perhaps not. It is seen by some teachers as debilitating rather than supportive. It's a nuisance to them and its value in improving the act of teaching and learning is unknown. Certainly these problems take time and create pressures on teachers, but perhaps the gain will be worth the cost.

Also having a far-reaching effect on the schools is the growing interest in developing minimal competencies. Parent concern, desegregation, and declining budgets all work to make "basic skills" an attractive focus. This creates much support for language arts, reading, and mathematics. There is decreasing interest in other subjects, including science, because they are considered by some parents not to be "basic."

Meanwhile, a positive force impinging on the Hardy schools is the apparent shift in the attitude of students toward schooling. It is far from meeting most teachers' ideals, but better than the violent objections of a few years ago. The cause of this change is unknown, but the atmosphere--as reported by teachers--is improved from the turbulence of the late sixties on college campuses and in high schools.[3] Peer pressure to "drop out," reject traditional values, or rebel seems to have vanished. In spite of, or perhaps because of, the pressures surrounding the classroom, one senses a positive attitude about learning among many students at Hardy school. This perception is not shared by all teachers, however, as complaints about "poor attitude" are occasionally heard. The changing attitude was not apparent at the junior high school, but did reappear again at the elementary schools. The result has been fewer discipline problems than five years ago, and shared goals seem to exist between student and teacher in many classrooms.

What, then, has been the outcome of all these pressures? I think it can be summarized by stating three growing reactions. First, there has been an increase in teacher militancy as teachers seek to find protection from the factors that threaten their positions. Teacher unions have become activist and the issue reached a peak this fall with the first strike in the district's history. The teachers seem to have found strength in the strike experience. More than one teacher reported the strike brought the teachers closer together, in addition to increasing their salaries and future negotiating strength.

Second, teaching appears to be less satisfying. There are more demands and fewer rewards. In my opinion, teaching always has been difficult. Recognition of this difficulty, which I believe grows in part out of the difficulty in learning, helps to explain many things one observes in the schools. For example, teachers tend to resist those things that make their job more difficult and are attracted to those things that make it easier or more effective. Resistance to innovation, appeal of teaching bright students, need for discipline, desire for smaller classes, resistance to administrative requests for personal goals are all explained by considering teaching in this light. At the Hardy cluster, the rejection of the newer but more difficult to teach science curriculum materials, and the reversion to a traditional text are manifestations of the phenomena.[4] (Obviously, this conclusion is not

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[3]However, one teacher in reading this report wrote, "[There is] a greater emphasis on jobs and competition--less on learning and idealism. Many of us did not find the 69-74 era a threat--it was almost inspiring."

[4]Again, a teacher's reaction to my statement is enlightening. Someone wrote, "In biology not a proper conclusion. BSCS was dropped, in part, due to lack of interest on the part of the student--the students did not like the green version (or blue). It was <u>boring</u>. They found that the book had little to offer. As a result we <u>kept</u> the labs, rewrote some, added many more--developed three levels of difficulty (three separate lab manuals) in an attempt to increase student involvement. More students are now involved--students of diverse backgrounds (LLD, and very bright, etc.) can all function in the same class. I don't think that this was <u>easier</u> than using the NSF curriculum."

shared by everyone. Neither is the disappointment with multiple texts, nor the annoyance with progress reports, the absence of art and music in the elementary classroom, and the decline in the number of science classes.) This hypothesis (teaching is tough, and getting tougher) also explains the acceptability on the part of teachers of the "back to basics movement," and explains why math teachers so readily fall into a standard routine. These things all make the job of teaching easier.

Finally, I believe the pressures on the school have created a situation where the systems responsible for providing the education of children have drawn inward and moved apart. The attention-directing factors and the relevant variables at the institutional level (central office/school board), the managerial level (principals), and the technical level (teachers) have always been somewhat different and the situation seems to have worsened. Teachers are responsible for the day-to-day operation of the classroom; principals serve as linkages or buffers between the technical level and the central office, which is concerned with exchange relationships with the environment, the community, and state and federal offices.

Each of the systems now seems to be functioning as a self-contained and separate entity. Mutual support is minimal. When the systems do interact, it creates tension or problems. The principal's staff spends hours developing and explaining complicated tardy and absence forms. Five tardies equal one absence! Five absences equal one suspension! But the teachers ignore this system. Although I saw the system explained for two hours on two different occasions by the assistant principal, not once did I see a student marked tardy, although there were many in the thirty-three classes I was in at the start of the period. The interest in tardiness at the managerial level was not shared at the technical level.

The teachers look to the managers for support, and in return they receive demands for "goals and objectives," reduced supplies budgets, fewer elective classes to teach (often the most interesting), increased class sizes and decaying textbooks. In spite of a very competent principal and because of situational constraints, the direct assistance provided to teachers during my two months of field work was minimal. Most of the interactions involved administrative requests rather than administrative giving. At the central office level, this lack of, or reduction in, support was very noticeable. The loss of mutual support among the technical, managerial, and institutional levels may be a problem to education in Urbanville. In the face of external pressures, the three systems should be working together, not drifting apart.

In my opinion, the existence of these three reactions -- teacher militancy, tougher teaching, and separate systems -- is important when planning for change. These reactions together with the external factors and the immediate impacts describe the setting in which the science education is occurring.

POTPOURRI

A number of observations and conclusions were not woven into the preceding story, yet their existence is important in this case study. Time and space limitations do not permit elaboration, but some of these items may help the reader to better understand this and other school clusters. Caution is urged in generalizing these notes beyond the current site.

1. The percentage of girls enrolled in the science courses in the high school is increasing. Students say this is due to encouragement from counselors, parents, and siblings to expand the roles for women.

2. The problems, issues, concerns, and needs are different for social science, mathematics, and science. They are also different for elementary, junior and senior high schools.

3. Many elementary schools have "glow" teachers who become leaders in various aspects of the curriculum. For example, there might be the SCIS teachers, or the MACOS teacher, or one particularly interested in math. Fifth and sixth grade male teachers seem to fill these roles most often.

4. As yet, the within-class activities have not been affected much by the changes in the political and fiscal environment. It seems to be just starting and no doubt will increase.

5. Hardy's experienced and able teachers found the National Science Foundation Institutes very valuable for exchanging teaching ideas and maintaining currency with their subject matter.

6. The high school football coach seemed to be an effective basic math teacher.

7. Abilities and personalities of teachers vary considerably. However, most I observed seemed quite effective.

8. Students and teachers seem to fulfill each other's expectations of their respective roles in the classroom.

9. Observations and testimony seem to confirm that secretaries in the schools are overworked.

10. A per-student science equipment budget of $1.25 for supplies and equipment is perceived by the staff as woefully inadequate.

11. Parents and elementary teachers are opposed to the use of calculators in math. They worry about not learning skills and becoming mentally lazy.

EPILOGUE

This report has presented the results of a case study designed to portray science education in a school located in a large urban area. The names of the schools and the faculty have been changed to preserve anonymity. The purpose of the case study was to apply a new methodology to the problems of science education for the purposes of helping to illuminate desirable future directions.

Tests, questionnaires, regression equations, and ANNOVA's, the tool kit of most science education researchers, are noticeably absent from this research study. But hopefully, greater understanding through description and analysis has occurred. The ultimate test of this or any other approach will be decided by those charged with the responsibility of making decisions concerning the future of science education. If this case study is found useful for making decisions or identifying areas for future study, then this methodology would seem to have a role in evaluation and science education research. The passage of time and the experience of further study will help us decide the value of that role.

Meanwhile, I now leave the yellow brick building, trimmed in white, with the school mascot painted on the chimney. I thank the friends I have made there for opening their classes and hearts to me. I hope I have done them justice by telling their story accurately.

REFERENCES

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APPENDIX - METHODOLOGY

In retrospect, it seems important to summarize the field work methodology and to describe the sources of data. Perhaps this will help the interested reader in judging the accuracy and pervasiveness of the conclusions of this study.

The data were obtained from six different sources: (1) semi-structured interviews (typically one hour long) where notes were taken concurrently; (2) in-class observations using a class observation form; (3) school documents such as daily bulletins, enrollment sheets, and the school yearbook (a valuable way to learn teacher and student names); (4) meetings I participated in or attended; (5) informal discussions in the hall, lunch room or teachers' lounge; (6) informal perceptions from just moving about the building. The data sources were of two general types: semi-structured, which included interviews, class observations, documents, and meetings; and unstructured, which included discussions and perceptions formed from watching and listening.

The traditional research criteria of validity and reliability play a different role in case studies. Case study results must be judged on such criteria as source criticism, recording accuracy, the relationship of the field worker to the unit under study, sampling, and the scope of the data sources.

The specific sources within each of the six categories are listed below.

Interviews

Semi-structured interviews were held with about fifty people during the eight weeks of the field work. The main selection criteria were likelihood of possessing needed information, availability, and representativeness of various groups: teachers, students, parents, etc.

At the district level, I interviewed the science supervisor and staff in the Research Office. The principals of each of the six schools (high school, junior high and four elementary) were interviewed extensively as well as selected support staff: registrar, counselors, and assistant principals. The department chairmen for math, science, and social studies at the junior and senior high school and fifteen teachers provided the bulk of information during the field work phase of the study. In addition, six parents, eight students, and two alumni were also very helpful in describing their impressions of the Hardy cluster of schools.

Class Observations

A total of thirty-three elementary and secondary classes were observed for one class period and records made during the visit. Duration of these observations was usually fifty-five minutes. In addition, drop-in observations (here defined as ten minutes or less) were

made in twenty-three classes. These were unannounced visits made either by listening through open doors or by walking in on laboratory experiments, student assignment time, or the instructional resource center where many of the social studies classes were held. These brief observations were intended to check on points noted in a previous visit and to observe classes in a more typical environment than one might expect during an announced class observation. (Parenthetically, it might be added here that very little difference was noted in lesson plans, teacher activity, or student behavior for announced or unannounced class visits.) All schools seemed fairly comfortable with the presence of observers. Probably this is due to a number of interns and student teachers found in these buildings.

The summary of classes visited is found in Table I.

TABLE I

Class Visitation Summary

Hardy Field Work

	Sr. H.S.	Jr. H.S.	Elementary	Total
Natural Science	12	6	4	22
Social Science	7	4	3	14
	9	6	5	20
	28	16	12*	56*

*Two classes in kindergarten and first grade were quite general and classification is based more on teachers' intentions than on actual activities.

The attention directed toward natural science (39% of the observations) is less than planned and reflects in part the fewer science classes offered in secondary school and the limited time devoted to science at the elementary level.

Documents

Many documents were perused to gain understanding of the field site. They are too varied and numerous to list completely but included such things as textbooks, tests, curriculum guides, course offerings lists, textbook adoption guides, school files, daily bulletins, school annuals, school newspaper, and the local city newspapers. A teacher's box was assigned to me for the two months of this study and I received copies of everything that went to the teachers. In addition, specific information on the district was available from the central office.

Meetings

Several meetings were attended where it appeared a better understanding of the school* might be gained. The field work at the meetings was usually to listen and watch and to record impressions. If the recording could not be done unobtrusively during the meeting, then it was done immediately afterward.

Meetings attended included meetings of the total faculty, science, math and social studies departments, instructional council, new teachers, parents, and students. About half were convened as part of this study. The remainder were normal meetings of the groups to which I was invited.

*The reader is reminded here that "school" refers to the target secondary school as well as the "feeder" elementary and junior high schools.

Discussions

An unknown adult in a school building is noticed almost immediately by curious teachers ("May I help you?") or students ("Who are you?"). Even custodians seem alert (anxious) to assume a hall monitoring role ("Are you looking for the office?"). This interest always seems strange to me, given the public nature of schools and my recent life on a university campus. It is somewhat like entering a federal building in Washington during the bomb-scare days of the sixties, or approaching the floor nurse in the obstetrics wing of a large hospital.

But this curious (helpful?) attitude does generate many opportunities for informal discussions. Field work in schools is filled with brief personal interactions: in the hall, lunch room, teachers' lounge, and even the rest room. And while recording these incidents is difficult, they occur with such frequency that I have no doubt they contribute to the wealth of information impinging on the field worker.

While I tried to use these instances as ways of uncovering "hidden truths" or discovering new issues, they were for the most part kept at the level of "Are you a new substitute?" "No, I'm here observing your science program!" Or, "How do you like the weather in Urbanville?" They did provide a way to meet the teachers and become less of a threat in their class and to substantiate a number of observations made in the school buildings. (Example: "Miss Jones, the students in this school seem quite well-behaved!" "Yes, although I wish they weren't so noisy in the hallways!")

My records show more than two dozen such contacts and there were probably twice this many that had some input into my data-gathering instrument.

Perceptions

Finally, a great deal of time was spent watching the actors in the school drama: students, teachers, administrators, janitors, parents, and others. These actors created impressions

as did the facilities, equipment, broken windows, clean floors, smoking area, hall posters, faculty dress, student dress, vice principal, minority students, football games, open house, and lunch rooms. Tht totality of these visual and audio inputs cannot be quantified, but my impression is that they influence the field observer a great deal. Noticing the need to hit or shove peers in the junior high, or an un-monitored, yet orderly lunch room in a senior high, cannot help but have a perceptual impact. It is the set of these received impressions that seems an important part of the methodology of case studies.

As a validity check on perceptions and other data, other observers were brought into the school for short periods and the case study report was reviewed by the principal and department heads. Nevertheless, whether or not others would respond to and remember the same stimuli is uncertain. The wealth of sensual information may be the field worker's greatest ally, but it may also be an enemy. A single dramatic event can have more influence on one's senses than a dozen common occurrences. The observer must guard against this uniqueness phenomenon.

GREATER SEATTLE SITE VISIT

To illustrate the use that this CSSE project made of site visit teams, the team report for the GREATER SEATTLE site is included next. The principal reasons for these visits were:

a. to confirm principal observations reported in the case study by the field observer

b. to assist in the development of "scenarios" for the national survey questionnaire

c. to identify new issues in contemporary science teaching and learning

d. to assist the observer in making certain special observations, interviews and interpretations

e. to further the coordinator's preparation for writing the assimilation chapters.

The site visits were conducted differently at different sites, partly because the needs of the field observers varied and the needs of the project changed. This GREATER SEATTLE visit was the first of the site visits.

The five reports are included in the informal form in which they were submitted. (Coding and omissions of names were done to preserve anonymity.) Note might be made of the difference in attention the individual visitor gave to pedagogy, subject matter, organization, and the relationships of school activity to university-based activity.

REPORT FROM THE SITE COORDINATOR

The first CSSE site visit was held in Greater Seattle November 1-3, 1976. Coordinator Bob Stake arrived October 24 to make arrangements. Assistance of the District Office was sought but little was received; but on the other hand, no obstacles were raised. The principals of the three schools to be visited made arrangements for interviews in their buildings.

Field observer Wayne Welch had been in the Hardy vicinity (high school, junior high, and elementary schools) since early October. He had been well received and made it easy for site visitors to do their work. He did not participate fully in the visit but did attend some sessions, particularly when the interviewees were people he would not have time to see individually.

This portion of the Seattle area has many of the characteristics of an older suburb. Most people live in single-family dwellings--with yards, gardens, and trees well developed. There are older business-lined arterial streets and at least one relatively new shopping area. Puget Sound and Lake Washington are not far.

The staff at the three schools are highly experienced. Many came here after serving earlier years in other schools. Few were younger teachers. Many of the younger ones are veterans of annual discharge and August rehiring. Budget limitations required an annual reduction in force (RIF'ing), but some of them had to be brought back to get school going each fall. A few teachers had been assigned to these schools to improve the racial balance. Budgets this year were not as spare as the previous two years, but there were many references to the shortage of funds for the schools.

The site visit team consisted of:

Arnold Arons, physicist, University of Washington
Jack Easley, mathematics educator, University of Illinois
Jennifer James, anthropologist, University of Washington
Howard Levine, evaluator, formerly of NSF, now at Berkeley, California
Bob Stake, coordinator, educational psychologist, University of Illinois

Efforts to add a local school administrator and a parent to the team were unsuccessful. Mr. Levine graciously agreed to join the team at the last minute so that the scheduled interviews could be carried out. Arons, Easley and Stake met on Sunday evening to discuss the schedule and aims. The other two joined the party the following morning. Professor Arons was unable to participate after Tuesday noon. All members wrote reports of their observations and these are appended.

An "open session for students or teachers who might want to speak to the panel" on Tuesday afternoon drew no respondents. The team used the time to discuss its observations and findings. Other sessions came off as scheduled.

Three sessions were held with teachers during their noon hour, a period of only 40 minutes. Although we arranged a lunch for them, the time went by much too quickly and these were perhaps our least productive sessions. Throughout the visit we frequently found ourselves in groups too large, and toward the end we found ways of splitting up for individual interviews. The large groups permitted respondents to react to each other, but it limited the time that any could speak, and perhaps for some, limited the frankness with which they would speak. Although team members wearied a bit of the descriptions of the programs in those schools, and occasionally felt the victims of puffery, for the most part they found the respondents candid and anxious to help.

By and large, the school people, parents and students were pleased with the programs of course work in their schools. They considered most of the teachers competent and conscientious. They were favorably impressed with administrative support at the building level. They expressed reservations about support from district offices--some of it contradictory--such as wanting more directives from district offices as to what should be taught, and at the same time believing the district officers have too little confidence in what teachers could take care of by themselves.

There appeared to be a strong feeling of need for greater uniformity of what will be covered in elementary courses, at least as a minimum accomplishment for "all" children. They wanted more communication among teachers and administrators, both as to what should happen and as to what was happening. Many respondents indicated that the goals of instruction should be more fully specified. Few indicated that the district faces the danger of having its goals lowered in order to achieve a greater uniformity of results. Few teachers expressed fear that they might be expected to teach lessons they were not capable of teaching or did not enjoy teaching, a possibility if a set of instructional objectives were to be required by the district.

A number of teachers bemoaned the loss of public support for the sciences. Math teachers seemed to see the support they wanted, but felt a need for materials and techniques for teaching older kids the basic operations not learned earlier. Social studies teachers did not feel that there ever had been support for teaching social "science" in the pre-college years, and were not particularly advocates of it themselves. When asked about the difficulty of teaching sensitive or taboo topics, none of them indicated that they had heard any trouble of that kind in these schools.

Enrollments in the various courses was dropping as total enrollment in these schools dropped, but not disproportionately. For graduation, a year of science was required, and most students took biology. It was reputed to be easier, more fun, less involved in mathematics, and less of a threat to the grade point average. Few people named this or any other high school course as containing subject matter that an educated person "just ought to have." Students enrolled in science courses or did not, as if there was rather little choice, once you decided whether or not you might be going to college.

It was surprising perhaps that there was not more feeling about whether or not geometry or physics were basic to an education--certainly there was lots of talk about basic education. For the most part, people were very much in favor of the basics, and by this, most of them meant reading and arithmetic, and perhaps, writing. They felt that these skills were essential to any rudimentary understanding of the concepts of the various disciplines, and seemed much more worried about the child who was not getting the basics than they were about the child who was bored by an overattention to simple tasks.* Some teachers were quick to add, to the definition of what is "basic," their favorite conceptualizations, such as conservation of energy, or human need to communicate. They were seldom rebuffed by others for "corrupting the movement"--but it was clear that more people wanted less teaching of the concepts and more teaching of the facts.

There was very little attention to test score results as such. Most of the teachers expressed little interest in or confidence in such data other than to tell them what they already knew. They were certain that students by and large are not sufficiently accomplished in the elementary learnings in <u>their</u> subject matter and other areas of study, and that the curriculum change should be mandated to improve that situation.

There was rather little interest in the question of how children as a whole, or individual children, think. Teachers did not see it as important to their jobs to find the unique obstacles to learning that might be blocking an individual learner. There seemed to be a conviction that failing to learn was more a failure to mobilize than a failure to fit new ideas into old experience. It wasn't that a child was marching to a different drummer but that he wasn't paying attention or just didn't have a sense yet of what marching is.

They did not see teachers as needing help in creating something, but occasionally needing help in dealing with the obstacles to learning: inadequate teaching materials, unwilling learners, an unsupportive public. They saw "Staff Development" as capable of being stimulative and providing a good opportunity for teachers to think about what they

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*They seemed more concerned that the recalcitrant learner would get in the way of class progress than that he/she would end up uneducated. Emphasis on "basics" to some was a way of re-establishing "tracking."

are teaching--but not often dealing with the real problems of teaching. They felt surely that they and all their colleagues could provide first-rate education if you gave them smaller classes, the text and demonstration materials they needed, and a decrease in the administrative obligations imposed on each classroom teacher.

The site visit team came away with a surprisingly uniform picture from teachers, students, parents and administrators. They had their separate worries, to be sure. But they saw themselves in a serious, not very exciting business; the business of education. They saw themselves as pretty good businessmen, wishing that times would change for the better, but confident that they could deliver on their promises and pretty well satisfied that there is not really a better way to run the shop.

Robert E. Stake

REPORT #2

1. I would have liked to have heard reactions to a somewhat more substantive scenario, such as #6b, in preference to the looser ones that were used.

2. I was struck by the categorical statements made by the high school girls we met, concerning an altered social attitude toward girls in science. I do not take this as meaning that the problem has been eliminated (I am sure one would find different attitudes in other places and among other girls in the same school), but I found their explicit statements profoundly encouraging and indicative of shifting attitudes.

3. I was disappointed by how frequently the conversation with teachers drifted into the eternal old complaints that have been hashed over ad nauseum. I felt that team members did very well to return the discussion to a more fruitful track when it did drift, but it was clearly difficult to keep it substantive.

4. NSF, in its current guidelines, is putting tremendous emphasis on evaluation within projects. (I realize this is being done under the congressional whip.) The more I look back over the past 20 years, however, the more I am led to question the importance of evaluations conducted during and immediately after the project and the more I become interested in evaluations conducted in subsequent years, after the initial novelty has been worn off. Are the results of the project still viable and in use? Has the entire thing softly and silently vanished away? If so, why? Did the project results influence other (e.g. commercial) operations? If so, how and to what extent? I suggest that NSF be urged to undertake some examinations of this kind rather than confining evaluations to recent events in which the so-called "Hawthorne Effect" is still likely to be a seriously confounding factor.

5. I noted that the teachers we talked with (particularly in the elementary and junior high) seemed not at all sensitive to the fact that competent and effective implementation of the better inquiry-oriented science and social science curricula might have the potential of significantly upgrading both the language skills (reading facility and reading comprehension as well as speaking facility) and arithmetical skills of the children. Teachers who have developed some genuine competence in the handling of such materials are, in my experience, far more sensitive to the impact of such curricula on the basic skills of the children, and they are then more ready to regard science and social science as having a place in the "back to basics" formula.

6. I note that we did not flush out any evidence of external pressure against the reading and discussion of "controversial" subjects. My guess is that this results from a combination of two effects: the choice of materials in the schools was relatively conservative; the community does not seem to have a self-reinforcing nucleus of vocal rightists. (In another area nearby there was a sizable uproar last year about the MACOS course at about the same time Congressman Conlan was objecting to it in Washington.

7. My own personal recommendation to NSF for the future: much less emphasis on new curricula and a major push in two directions: (1) increase the competence and security of presently active teachers in handling the improved curricular materials that now exist (quicky work-shops and vague discussions of "philosophy" of the program will not do; they must develop command of the subject matter): (2) improve what is going on in the universities so that newly graduated teachers are in command of the substantive content of the new curricula and are not in need of remediation at the instant they graduate. (N.B. Both activities require serious implementation of the best current knowledge concerning psychology of learning and theory of intellectual development.)

Arnold B. Arons

REPORT #3

Introduction

This site visit report is divided into two major sections. The first section contains eight numbered paragraphs. Each paragraph begins with a finding which, based upon my observations at the site, I believe has a high probability of being true. Using these findings as premises, I inferentially develop the remainder of the paragraph drawing conclusions about which I feel less certain. Finally, where appropriate, I conclude each paragraph with evaluative judgments or recommendations.

The second section presents a more holistic and integrated view of science education at the site. Rather than repeating the findings from part I, I try to describe science education within the context in which it is found. This is a more general task and leads me to make statements which are more evaluative than descriptive. Taken together, I believe the two parts provide an accurate representation of the site.

Part I: Findings

1. There is absolutely no articulation between the three major grade units (K-6, 7-9, 10-12) and very little articulation between classes within a unit. The major exception is K-6 math which uses a fairly new district wide program. It has a significant amount of structure and standardized testing. Given the difficulties surrounding articulation, this finding is not really surprising. What is a bit surprising is the strong desire expressed by teachers at all levels for articulation. This, especially in the absence of any actions taken to more fully articulate the various programs.

Various hypotheses (neither mutually exclusive nor jointly exhaustive) can be postulated in an attempt to explain this desire: (1) teachers would like to know what they can legitimately expect from students entering their classes; (2) teachers have a great sense of the ad hoc, a feeling that maybe they're not teaching the right material, an insecurity--they need some kind of curricular floor to act as a psychic net; (3) the constant reshuffling of teachers given fiscal cutbacks makes the job of teaching that much tougher and this constant new exposure to new environments could be softened if there were district-wide (one teacher even advocated nation wide) standards.

I believe that given the individual nature of education (students, teachers, communities) it is better to err on the side of less articulation than to force individuals into a prescribed structure. Therefore, I am not particularly worried about what the faculty perceives as a lack of articulation, especially since it is occurring where it is most needed (K-6 math). The problem is important only to the extent that it is a psychic burden on the faculty. Nevertheless, I do believe that there should be more communication between teachers of the three basic units as well as inter and intra departmentally.

2. The treatment of science on the K-6 level is really nothing more than show and tell. This school district has had monetary cutbacks which have shortened the school day. Most of this day is spent with reading, writing, spelling, and arithmetic. Although the students really enjoy science, it can only be fitted in two or three times a week. There is no money for prepackaged materials so the teacher's preparation time for science is greatly increased which correspondingly diminishes the variety of lessons available. The teachers endorse a sequenced approach to science similar to the math program.

I believe that the above described program is presenting the absolute minimum (if that) amount of science that is acceptable. Aside from the obvious problems of time and money, I feel the whole effort is suffering from a lack of rationale. Why teach science to children? What should we expect a third-grade child to know about science?

3. The district-wide teaching of science is being squeezed between a perceived need for both the basics and vocational education. Science is being depreciated. Almost everyone I spoke with thought that the basics (3R's) came first and that science was not included in the basics. The elementary school teachers even noted that a survey of parents was conducted and that the basics were overwhelmingly rated as the number one priority. On the high school level getting a job is a high priority. The most direct route to this end is vocational education. Science is not perceived as resulting in cashable skills except if one is to be a professional scientist. This, of course, leads to an elitist view of science.

In the jargon of the 60s, science is not being perceived by the students as relevant. One solution being tried in this district is the offering of directly relevant courses (e.g., plant indentification, horticulture). But this misses the point. If science is ever to move from an elitist position, we must demonstrate how science affects our lives across many dimensions (e.g., public policy, factually, methodologically, and conceptually).

4. While the science department is not destitute for funds, its monetary resources continue to be cut back. The department has no budget for equipment. Its expendable supplies budget was cut last year by 25%. Courses previously offered have been dropped and one biology teacher says that she does not have enough books to go around. Despite all this, the program is generally strong. The query I want to raise is this, at what point do the cutbacks result in a qualitative loss in the program? Alternatively, how much additional money would be needed to significantly raise the quality of the program?

5. Everyone agreed that the most important parts of the learning equation are the teacher and student. The curricula materials are secondary. What seems most important is attitude. Students didn't talk about how much or little their teachers know. They talked about how teachers related to students. Faculty didn't talk about IQ points or student's ability, they talked about student attitude and desire to learn. On this latter point the faculty were generally derisive. There was a feeling that students didn't care as much about learning as in the past and this was attributed to outside interests, more students holding jobs, and a general decline in discipline. The only comment about curricula was that the core curricula were fine but that enrichment courses relating science directly to the world would be useful. The only exception to this is the basic math course which seems to be in need of total revision.

6. The average age of the faculty continues to rise and no new teachers (those entering directly from college) are added to the faculty. This same problem is happening on university campuses with the same effects: (1) how can you keep teachers knowledgeable about current trends in both subject matter and learning theory?; (2) how can you keep teachers revitalized?; (3) older faculty are most resist nt to change. An example of this last point is resistance to the hand-held calculator. The teachers in the primary grades could not even conceive of allowing hand held calculators in their class rooms.

7. The number of women in the high school science and math classes is about 50%. This figure is only meaningful when viewed from the perspective of a trend. However, in absolute terms, I would think that the 50% figure is quite desirable. No one I spoke with seemed to

have a simple explanation of this but the role of the counselor was played down. The students didn't think the counselors were of much help in anything. The best explanation seems to be the general societal trend and the belief that women can now find jobs in science.

8. There is a great difference between the student's perceptions of classes in mathematics and those in science. A general comment about math classes were that they were dull. Science was perceived as being more fun although the point made in #3 about relevance should not be overlooked. I got the impression many students looked forward to science (at least biology and the electives) but no one seemed to look forward to math. This relates to the point made in #5 regarding the importance of teachers. The math teachers seemed dull to me. One gets the impression it's just a job and they would rather be somewhere else. The science teachers here are a much more lively bunch who seem genuinely involved in their work and spend a lot of extra hours at it.

Must math be dull? Of course not, but one must admit that the science teacher has an easier subject to enliven. How can such a stodgy department be rejuvenated, given the hiring problems?

Part II: Summary

Looking back over my eight findings, I discover that they are almost all essentially negative. This should not be surprising given the negative epistemology of us evaluators. The most important point, however, is that this is a good science program--not great, but good. The teachers are competent and, for the most part, interested. The students are not in need of material well being. There is a good supply of equipment. The courses are current and there is a good selection.

The findings I discuss could probably be made about the English department or art department. They are not problems inherent in science education. They are problems inherent in all of education. I don't believe that this was always the case. Twenty years ago the NSF made a convincing case that science education was lacking both good curricular materials and knowledgeable teachers. Due in large part to its efforts, these problems have been greatly ameliorated.

This is not to say that there aren't any problems unique to science education. For example: intelligent use of the hand held calculator, the higher costs associated with lab related sciences, the dual mission of teaching for both a scientifically literate population and training future scientists, and the potential problems of value laden subject matter in the social sciences. But I believe that these problems are neither of the magnitude of those expressed in the findings nor are they amenable to federal solutions. If one were to ask if there were still a role for the NSF in science education the answer would have to be-- No, not at this site.

Howard Levine

REPORT #4

Regarding Site Visit Purposes

1. New issues in science education.

The basic issues affecting science curriculum at this site were administrative and economic. The teachers were faced with changes in curriculum requirements that directly affected science offerings yet seemed to have very little input in decision-making procedures on a district level. The science requirements throughout the district had been reduced, ostensibly, as a reflection of a school board philosophy allowing students to choose their own classes (especially at the high school level).

There also seemed to be an increasing concern on the part of parents and students with the vocational value of science. Upper-level mathematics, chemistry, physics, etc. were not viewed as directly related to job skills.

District and community priorities have shifted away from science and toward social problems over the last ten years. This is, in part, a reflection of the question of the transfer (through bussing) of minority students and staff.

An effect of transfers is an increased number of "slower" students. They do not fare well in regular classes. Special programs for these students in science are very limited. Science very quickly becomes a subject for the elite student and is feared by others.

Another administrative problem is economic. Teachers are laid off and/or transferred depending on levy successes. The result is reduced staff and unstable programs that must be reorganized constantly. There is noticeable resentment on the part of some minority teachers and some older teachers who have been reassigned new subjects.

2. Field observations.

Comments will be withheld until review of case study draft.

3. Refine the scenarios.

In my opinion the scenarios are too limited in their focus. They do not inspire much discussion because they are simplistic. For example Scenario C, which was used in all three of my sessions (bad luck, I guess) is very limited. Scenario 3 is much better. I think the scenarios should now be rewritten to incorporate the problems cited by the teachers: 1) educational priorities, 2) curriculum requirements, 3) money for textbooks, 4) unstable staffing, and 5) vocational interests. I feel open discussion around these issues would be more successful than the more stilted discussion resulting from fixed scenarios.

CSSE Project Questions

1. What is the status of precollege science teaching?

Over the last ten years there has been a definite drop in the importance of science courses (primarily upper-level mathematics, chemistry, physics, etc., rather than social science). This is reflected in the priorities of the community, parents, students, and in the curriculum requirements set by the school board.

The result is less money for books and equipment, less enrollment, and less staff. New courses tend to appeal to creative interest (horticulture, edible plants, oceanography) rather than academic science (physics, chemistry, calculus). This is also a reflection of the shift away from precollege towards preoccupation priorities.

At the same time there has been an increase in interest in social science courses, particularly those that deal with cultural and social problems. This may also be a reflection of the changes in HEW guidelines.

The change in priorities is illustrated not only by the school district's actions but also by the fact that the district science adviser appears to have no significant impact on curriculum development.

2. Conceptualizations of science held by teachers and learners.

There is a split here between the practical and the abstract. Traditional (older) teachers maintain a basics approach, teaching concepts with minimal concern for content, although aware of the importance of teaching methods. Newer teachers show an interest in "creative science," especially in areas in which they have particular training or interest. None of the teachers is happy with the current priorities limiting science, and more than one noted "we need another Sputnik." All of the teachers made a concerted effort to continue their education and seemed up to date in both content and methods.

3. What happenings in school and community are affecting the science curriculum?

As noted before, the social upheavals of the sixties have clearly replaced the science war of the fifties. The community seems more concerned with social relations and personal security (economic and psychological) than the advancement of science. The priority is not to beat the Soviet Union in technology but instead to survive as a viable society.

Jennifer James

REPORT #5

Science is perceived differently in its 3-4 brances. In biology, there is a serious attempt at a pupil-related program. Special courses for gifted and slow learners have been replaced by a system of 3 levels of lab guides, which guide the student through Biology 1 and 2. The level is chosen by the student but recommendations are made on the basis of a BSCS general test. Horticulture is available through the vocational department plus environmental sciences.

In chemistry and physics there is much less choice: A standard curriculum of general organic chemistry is accompanied by a standard Physics course. The limited perceptions of flexibility and applicability in chemistry and physics is obvious.

In athematics, there are essentially two tracks. Algebra, geometry, trigonometry, coordinate geometry, and calculus constitute the academic track, and general mathematics courses provide practical computation training for the non-college bound students.

In the social sciences, however, there is much less division between different tracks and also a fairly wide variety: civics, history, psychology and sociology.

Methodologically, the GREATER SEATTLE site visit raised some interesting problems:

1. The three scientists each were accustomed to a certain style of social science (James - ethnographic participant observations, interviews, etc.; Arons - cognitive interviews; and Levine - evaluation strategies). While this is atypical, other sites may experience a similar conflict between preferred methodologies of site visitors and the expected style of the site visit.

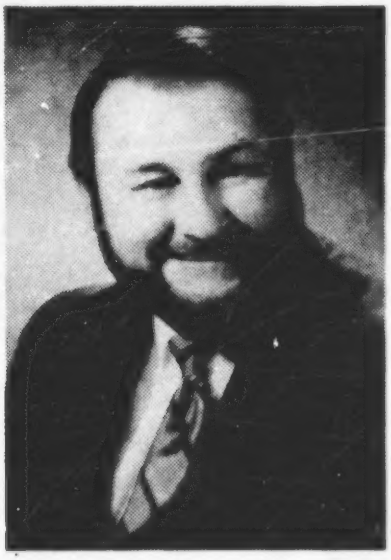
2. While coverage was a goal, efficiency of the work in terms of utilization of observers was not optimum because, primarily, of the difficulty of finding time for teachers and others to be interviewed. Wednesday was the worst day, because time scheduled for writing reports was not so used. No one wanted to write before completing their sessions. The talk on Tuesday, waiting for any visitors who might have come, was valuable as consultation, but might have been planned as such with an agenda.

3. It was difficult to evaluate or revise the scenarios used in interviews because so little reference was made to them. What there was was extremely general. No site visitors suggested they were useless as stimuli--however, it was far from clear how they might function in a mail survey.

4. In the initial meeting with the field observer, an impression of a rather outstanding science department was conveyed. However, by the end, the tendency was to limit that rating to the well-developed extra set of options in environmental science. The staff-developed multi-level biology workbook seemed to provoke a lot more textbook searching than it did observation of planaria in the one lab session that was visited. Students were docile; there was no great show of interest. Possibly, there are other more outstanding features, which were not seen by the site visitors. To the extent that quality breeds contentment, these seemed to be an impression conveyed by the observer. Money for supplies was clearly one issue. Were there any others?

I think NSF could help with the support of science courses that would relate to students, e.g., materials science, more interesting mathematics, ethnography of Western Societies; how history of art, technology, law enforcement, family life, music, and science relate; war and peace and their causes. History of the Northwest, Southwest, Southeast, Northeast sections of the country; how to read a newspaper, etc. But I am dubious about the value of textbooks. Because of the budget crunch they're mostly used as references. Pamphlets and lab materials would be valuable, if cheaply produced, or bound in plastics for longer survival. Handbooks of reference material could be useful, even encyclopedias of science topics at a high school level, e.g., Science Yearbook published by World Book. Perhaps all that's needed is a cummulative index to their volumes. (The science establishment is otherwise very little in evidence.) Science appreciation and math appreciation courses are needed for teachers and "turned-off" pupils.

John A. Easley, Jr.



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Wayne Welch has been associated with nearly two dozen evaluation projects since 1965, either as director or as consultant. He is a past president of the National Association for Research in Science Teaching and has also held offices in the American Educational Research Association, the American Association for the Advancement of Science, and the National Science Teachers Association. He has been listed in Who's Who in America (1974, 1976), American Men and Women of Science (1972), Educational Leaders (fourth edition), and International Men of Science. The author of numerous funded proposals, Wayne has also written articles published in such journals as the Journal of Research in Science Teaching, Science Education,

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